Temperature extremes and differences in the State of Washington for the years 1894 *and* 1895.

Stations.	1894.		1895.		Difference.	
	Mean of—		Mean of—			
	Max.	Min.	Max.	Min.	Max.	Min.
Western part.						
Blaine	76.9	47.6	75.1	42.2	—1.8	—5.4
West Ferndale	78.8	44.0	76.6	46.1	—2.2	+2.1
East Sound	69.2	53.4	70.6	50.3	+1.4	—3.1
Olga	70.6	53.6	68.4	50.7	—2.2	—2.9
Tatoosh	62.2	51.8	59.4	49.8	—2.8	—2.0
Neah Bay	69.3	50.7	66.9	48.0	—2.4	—2.7
Port Angeles	67.1	51.5	64.6	47.9	—2.5	+3.6
Stillaguamish	77.4	46.9	73.1	42.8	—4.3	—4.1
Snohomish	72.6	51.5	74.2	46.2	+1.6	—5.3
Seattle	75.7	56.1	71.6	52.5	—4.1	—3.6
Tacoma	76.9	53.5	72.5	48.9	—4.4	—4.6
Olympia	80.0	49.9	79.6	45.4	—0.4	—4.5
Fort Canby	66.7	56.2	63.9	52.2	—2.8	—4.0
Means	73.6	51.3	71.9	47.6	—1.7	—3.7
Eastern part.						
Bridgeport	94.4	56.5	90.8	46.1	—3.6	—5.4
Fort Spokane	92.5	51.2	88.9	45.0	—3.6	—6.2
Lakeside	87.2	65.8	85.1	59.7	—4.1	—6.1
Spokane	86.8	56.0	82.8	52.3	—4.0	—3.7
Rosalia	84.9	44.8	81.8	44.7	—3.1	—0.1
Colfax	82.6	50.3	81.4	45.7	—1.2	—4.6
Moxee	90.3	55.3	87.9	50.5	—2.4	—4.8
Fort Simcoe	87.7	59.8	84.7	57.6	—3.0	—2.2
Kennewick	92.5	63.3	84.4	54.4	—8.1	—8.4
Ellensburg	83.4	52.8	85.8	54.3	+2.2	+1.5
Hunters	80.7	45.3	76.5	39.6	—4.2	—5.7
Waterville	87.3	51.9	81.1	50.0	—6.2	—1.9
Walla Walla	91.2	62.4	86.9	58.1	—4.3	—4.3
Pomeroy	79.7	64.7	83.2	60.7	+3.5	—4.0
Dayton	88.8	57.4	85.4	53.3	—3.4	—4.1
Mean	87.4	54.6	84.2	50.3	—3.2	—4.3
Mean of whole State	80.7	52.7	77.9	48.9	—2.8	—3.8

We thus see that we have here to do with a wide-spread phenomenon, in which the smoke from forest fires plays a very subordinate part; there must have been some general cause at work. The centers of areas of low pressure have rarely passed over this region during the current month, and the centers of areas of high pressure have been unusually persistent; but we do not go backward very far toward the cause when we say that the low temperature and the dryness were due to the excess of pressure, as these three climatic features are generally associated together, and neither one can be spoken of as the cause of the other, but they all alike follow from one feature in atmospheric motion that immediately precedes them, namely, the slow descent of the upper air toward the earth's surface. The charts of monthly mean temperatures and pressures and winds for the Northern Hemisphere show that an area of high pressure whose center is over the eastern Pacific ocean between latitudes 20° and 40° moves northward during half of the year, say from April to August, and thence slowly backward. It usually reaches its northern position in latitude 40° during August, at which time it also approaches nearest to the coasts of Washington, Oregon, and British Columbia; sometimes an arm stretches far northeastward over these States. Such an area of high pressure, with comparatively clear, cool, dry air is an area of descending air, and when abnormally cool, dry weather prevails over Washington and the surrounding country, as in the current month, it simply means that there has been an unusual flow of northerly winds over that region due to the unusual position of the area of high pressure; that is to say, the region in which air descends to the earth's surface has been pushed to the north and east a little beyond its ordinary position. Perhaps we may infer from this that the regions where air ascends have been pushed correspondingly far to the south and east. In order, therefore, to arrive at a fundamental explanation of the cause of the cold August in the State of Washington it will be necessary for us to explain how the region of descending air and high pressure came to be so far toward the northeast. We shall not attempt to present in detail the mechanics of this process, but in general we may say that the atmosphere moves in complex curved paths around and out of, and again around and into, the regions of high pressure and low pressure. No simple drawing could present the irregularities of the path of the air as it passes from the high to the low pressure, and from the upper strata to the lower strata, or vice versa. If we follow a particle in its path we shall find it subject to forces and pressures that push it now toward and now from the equator, now upward and now downward toward the surface of the earth. Its motion is largely determined by its own intrinsic density; the denser it is by reason of coldness or dryness the more it is drawn down to the surface by gravity and driven toward the equator by centrifugal force, and, on the contrary, the lighter it is, by reason of its warmth and moisture, the more it is pushed upward and toward the polar region. What is true of the smaller masses will be true of the large aggregations. If the region of high pressure (which is properly called a pleiobar) over the Pacific were, during August, 1895, fed by air a little colder or drier than usual, and therefore a little denser than usual, it would assume a more southerly position and bring lower temperatures to Washington; if the air within this pleiobar descended more slowly than usual, giving it more time to cool by radiation, then it would reach the earth's surface colder, and would bring lower temperatures to Washington. It is by some such process as this that the editor would explain the low temperatures of August, 1895. We are not yet ready to foresee when the pleiobars and meiobars, or the great areas of high and low pressure, will have positions unusually far to the north or south, or east or west of their normal positions, but that they must change, and for the reasons just given, is sufficiently evident. We must master this feature in the mechanics of the atmosphere before we attempt to explain the variations of the seasons by introducing any other principle.]

AN AURORA IN SOUTH CAROLINA AND KENTUCKY.

The Weather Bureau observer at Charleston, S. C., Mr. Lewis N. Jesunofsky, describes the aurora of the 26th, as follows:

An aurora was observed at 10.47 p. m. to 10.58 p. m. Altitude, 24°; azimuth (counted from S. to W. to N., &c.), 110° to 190°. A dark segment or arch rose to 17°, with a crown of light to 24°, one large streamer lasting from 10.51 p. m. to 10.53 p. m.; azimuth, 116° to 122°, and altitude 30°. The display was accompanied by a thin veil of vapor, through which the stars could be seen.

The voluntary observer at Greendale, Fayette Co., Ky. (Mr R. I. Spurr), also notes an aurora on the 26th.

These widely separated stations certainly experienced two independent auroral displays. Both stations were near areas of thunderstorm development. No other stations near by record having seen an aurora.

These cases relate to those interesting sporadic auroras whose occurrence illustrate the general principle that the auroral light is frequently and probably always low down in the atmosphere, emanating from a layer of electrified vapor lying between regions of cold, dry, and warm, moist air, respectively. In the winter season the warm, moist air is generally above the cold and dry air, but in the summer season instances may occur where, for a short time and over small areas, the cold, dry air is above and, of course, slowly settling down. In the present instance South Carolina and Kentucky were covered with a lower layer of warm, moist air, but above this thunderclouds existed, with a great display of lightning over these and the adjoining States. An extensive West Indian hurricane to the south of Cuba was moving westward. It was mentioned by the present Editor as early as 1874 that a region of auroral displays is often bounded on the south, east, and west by a region of thunderstorm development, as though the violent discharges from highly-electrified air shaded off into gentler discharges in the distant regions, where the air was less highly electrified. A mass of air (or rather the moisture and dust contained in it) may carry a charge of electricity a great distance, and may gradually get rid of it by a series of discharges, at first violent, as in the lightning flash, but gradually diminishing, as in the luminous or phosphorescent clouds and the most brilliant forms of aurora, until finally the discharges can give rise to only the feeblest auroras. This gradual diminution in the intensity of the discharge may depend upon a corresponding gradual diminution in the quantity of vapor in the air or on a gradual change in the condition of the vapor, namely, the difference between aqueous vapor and ice vapor. In the Annual Report of the Chief Signal Officer for 1876 the present Editor has given a study of the aurora of April 7, 1874, and the following quotations, from page 309 of that volume, are here given:

(*a*) The auroral light exists sometimes as patches or clouds, but more frequently as luminous lines [more or less closely packed together] inclined to the earth's surface and approximately parallel to the free magnetic needle.

(*b*) The luminous lines are associated together, forming wave and cylindric surfaces; such surfaces appear sharply defined in the portions where their tangent planes are directed toward the observer, giving rise to the appearance of beams or streamers which are, therefore, ill defined on one edge, but sharply defined on the other.

(*c*) The luminous wave surfaces are themselves arranged parallel to each other, giving rise to arches or belts across the sky which, when the observer is favorably situated so that his lines of sight are nearly parallel to the luminous lines, are seen by him as striated belts or arches, each stria of which corresponds to an element of the wave surface, and which structure is well described by one observer as resembling the vertebrae and ribs of an animal. A slight curvature in the luminous lines, or a perspective effect, prevents the striated appearance from being well seen except near the meridian. When the luminous lines are quite straight, and especially when associated together in perfect parallelism, but without being grouped into wave surfaces, there results the corona around the magnetic zenith with "merry dancers" on all sides, as recorded by one observer. This phase of the aurora is probably best seen when the luminous lines are comparatively short.

(*d*) Inasmuch as the definite edge of a streamer is simply an optical effect produced by viewing those portions of a curved surface that lie in the tangent plane that passes to the observer, it follows that another person at a distance, viewing the same wave surface will receive from a slightly different portion thereof the impression of a definite streamer, if, indeed, he sees any at all. For a similar reason, that which appears to one person as a well defined arch or belt near his zenith will appear to an observer farther south as a collection of streamers which may, in fact, easily become so faint or ill defined as to be scarcely noticeable, while the streamers which he does observe, as such, may be formed by an entirely different set of luminous lines and surfaces. A third observer farther to the north and looking southward may, with equal ease, be observing quite a different object from either of the others. The statement is, therefore, warranted that although the auroral light emanates from definite points and lines, yet the arches and streamers made up of these have no proper locus.

(*e*) The elementary luminous lines have motions both transverse and parallel to their direction, but in addition to this, slight changes in the flexures or arrangement of the luminous surfaces, arranged, as they often are one behind the other, may give rise to a complete change in the appearance of the arches and beams. Thus it results that the movements of the arches up and down, or north and south, and the movements of the beams or striæ, take place in a manner entirely diverse from the changes going on among the luminous lines.

(*f*) A comparison of the apparent eastward and westward angular motion of the waves near the zenith of any station with the apparent nature of the streamers observed from stations farther south would, if the same objects were observed, afford an additional means of determining the average elevation of the general mass of light. The data at hand as to velocities are too crude to afford precise results in the present case. The general indications are, however, very strongly in favor of the conclusion that the luminous lines were within 10 miles of the earth.

(*g*) The electric phenomena of the atmosphere embrace on the one hand lightning attending cumulus clouds, and, on the other, the aurora attending cirrus or stratus and haze, and in both cases the electrification of the atmosphere is evidently primarily due to the inductive influence of the earth. Between these comes a third class of electric discharges, that, namely, which gives rise to the phosphorescence of clouds. Such phosphorescence was noted during the present aurora on April 7, 1874, at two stations. It has been observed by myself in Washington on occasions too numerous to enumerate, when the whole heavens were obscured and rain or snow imminent; especially has it been remarkably distinct on the edges of the banks of clouds advancing from the northwest, and immediately preceding a sudden change from warm, moist, southerly to cold, dry northerly or northwesterly winds. It has also been frequently recorded in connection with the lightning and rain of hurricanes. In fact the luminous or phosphorescent cloud due to the silent discharge of electricity between its component atoms is a far more frequent phenomenon in these latitudes than either lightning or auroras, and connects together all the luminous electric phenomena of the atmosphere in such a way as to show that while the electricity may be due to the induction of the earth, the form of the discharge is due to the state in which the atmospheric moisture exists at the time.

(*h*) It accords with the preceding views that we find the beams and arches higher above the ground and far less numerous and brilliant in the west than in the east, and that, in general, the lower Lakes and New England have ever been distinguished by brilliant auroral displays, since here not only mountains with their high electric tension, but moisture and rapid alternations of temperature predominate.

The above long quotation shows that we may expect local auroras whenever dry, cold air separates two regions of highly electrified air. The extent and brightness of the auroral display depends upon details that we can not yet enumerate.

As illustrating the weather conditions and thunderstorm phenomena over the auroral region that lay between the local storms of the Ohio Valley and the hurricane south of Cuba on the evenings of August 25 and 26, we give the following quotation from the letter of Mr. H. W. O. Margary, voluntary observer at Eustis, Lake Co., Fla.

DATA OF ELECTRICAL STORM AS SEEN FROM OBSERVATORY GROVE, EUSTIS, FLA., AUGUST 25, 1895.

6.30 p. m.—Local time. Wind light northeast. Electrical storm in southwest with constant lightning among two or more strata of clouds as if from one to the other strata, with an occasional flash to the horizon. Another dense bank of clouds slowly approaching it from the north, and also a bank high up in northeast.

7.00 p. m.—Rain began to fall in west from clouds, with clear space to horizon below, showing clearly in several places on the clear sky of western horizon. Numerous small clouds moving from different directions toward main body of clouds in southwest.

7.15 p. m.—Clouds rapidly gathering from all quarters toward the southwest; very dense; lightning in southwest and north. The chief point from which the lightning comes is a black, fleecy cloud in southwest, about 50° to 60° above the southwestern horizon. Rain increasing along western horizon in spots. Wind getting easterly but very light, at times up to 5 or 6 miles an hour. Lightning increasing in east. Wind getting puffy and very distant thunder at times, but more continuous than heretofore, and getting louder.

7.30 p. m.—Appears to be raining heavily in west-southwest and a shower in the west and northwest, but all separate; wind still light northeast to east.

7.35 p. m.—A heavy belt of black, tongue-like, ragged cloud moving up slowly from south and southeast; lightning now principally in north along horizon; three northern clouds, that passed partly to westward, seem to be absorbing the electrical clouds in southwest.

7.50 p. m.—Wind comes from west and very light, and, at 7.53, back again to east; variable from east and west; light puffs.

8.20 p. m.—Storm passing off to northwest, as the clouds from it have absorbed those in southwest and carried them to northwest; lightning still quite vivid in north.

OPTICAL PHENOMENON.

It may be interesting to publish and explain the following phenomenon, specially communicated, from the Ohio Weather and Crop Report, by Mr. Samuel W. Courtright, voluntary observer at Circleville, Ohio. He states that—

On February 12, 1895, about 9.30 p. m., a beautiful phenomenon was witnessed in the heavens, almost in the zenith. It resembled a distinct and perfect rainbow, and the moon, which had risen to a height of about 45°, was in the center of a beautiful cross of bright, light yellow bars. These bars crossed each other at right angles on the face of the moon. The horizontal bars described an arc of about one-fourth of the heavens, and at about 15° on either side of the moon was a similar cross in fainter outlines. The eastern sky was misty and heavy, while the western sky was clear and the stars shining brightly. The phenomenon was witnessed by a great many of our people.